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ESTIMATING THE DENSITY OF PORCUPINES IN SEMI-ARID SARISKA VALLEY, WESTERN INDIA[1]

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(*With three text-figures*)

Key words: Indirect estimates, direct estimates, dung decay, pellet groups, defecation

The population of the Indian crested porcupine (*Hystrix indica)* was estimated over a period of 3 months (May-July 1989) in semi-arid Sariska valley in the Sariska Tiger Reserve, Rajasthan. The methods included count of pellet groups in four transects each in three vegetation types, and direct counts of animals in a vehicle at night. The data collection using these two approaches was repeated 17 times. Calculation of density for indirect estimates involved data on the pellet decay rate and the defecation rate (of captive animals). The animal density was estimated to be 8.8 ±2.4 animals/ sq. km through direct count, while pellet group count provided an estimate of 12.4 animals/ sq. km with a variation of 0.9 to 24.9 animals/ sq. km in different habitats. The influence of some factors such as possible use of latrine sites and slow decomposition rate on density estimates are discussed.

INTRODUCTION

To estimate the population density of animals in the wild, quantifying faecal matter abundance, decay and defecation rate is considered to be useful and convenient (Neff 1968, Rowland *et al.* 1984). Although a number of studies have been conducted elsewhere (Putman 1984, Koster and Hart 1988), in India only a few studies have estimated the population of wild animals using this method (Sale *et al.* 1990, Dekker *et al.* 1991).

The Indian crested porcupine *Hystrix indica* Kerr is a nocturnal animal that reportedly feeds on crops (Alkon 1983, Gutterman 1987, 1988) and on the bark of trees (Choudhry and Ahmad 1975, Sharma and Prasad 1992). In spite of its economic importance, few estimates of its population density in the wild are available. Being nocturnal, small in size and shy of humans, it is hard to observe and very difficult to estimate its population. Therefore, methods involving indirect evidence can be very useful for estimation of its population. During the summer of 1988, the last of three consecutive drought years, comparatively large numbers of porcupines were seen in Sariska valley in the Sariska Tiger Reserve. This was a unique opportunity to estimate its population using direct sighting and faecal abundance.

The aim of this study was to estimate porcupine density using pellet group density, and to compare the results with that obtained using direct observations.

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Study Area

Sariska Tiger Reserve (27° 20' N and 76° 25' E) is a dry deciduous forest (Champion and Seth 1968) located in the semi-arid tract of Rajasthan in western India. The weather is dry and hot during the day throughout the year, barring the monsoon when it is hot and humid. There are three distinct seasons: winter (November-February, with night temperature as low as 3 °C), summer (March-June, day temperature up to 47 °C) and monsoon (July-October). Average annual rainfall is *c.* 650 mm, most of which falls between July and September.

The study was conducted between May and July 1989 in the Sariska valley (Fig. 1). The vegetation of the study sites consisted of *Ziziphus* scrubland, mixed woodland and *Ziziphus* woodland (Sharma and Prasad 1992). The hills surrounding the valley had forests dominated by *Anogeissus pendula* and were little used by the porcupine (Sharma and Prasad 1992). There was

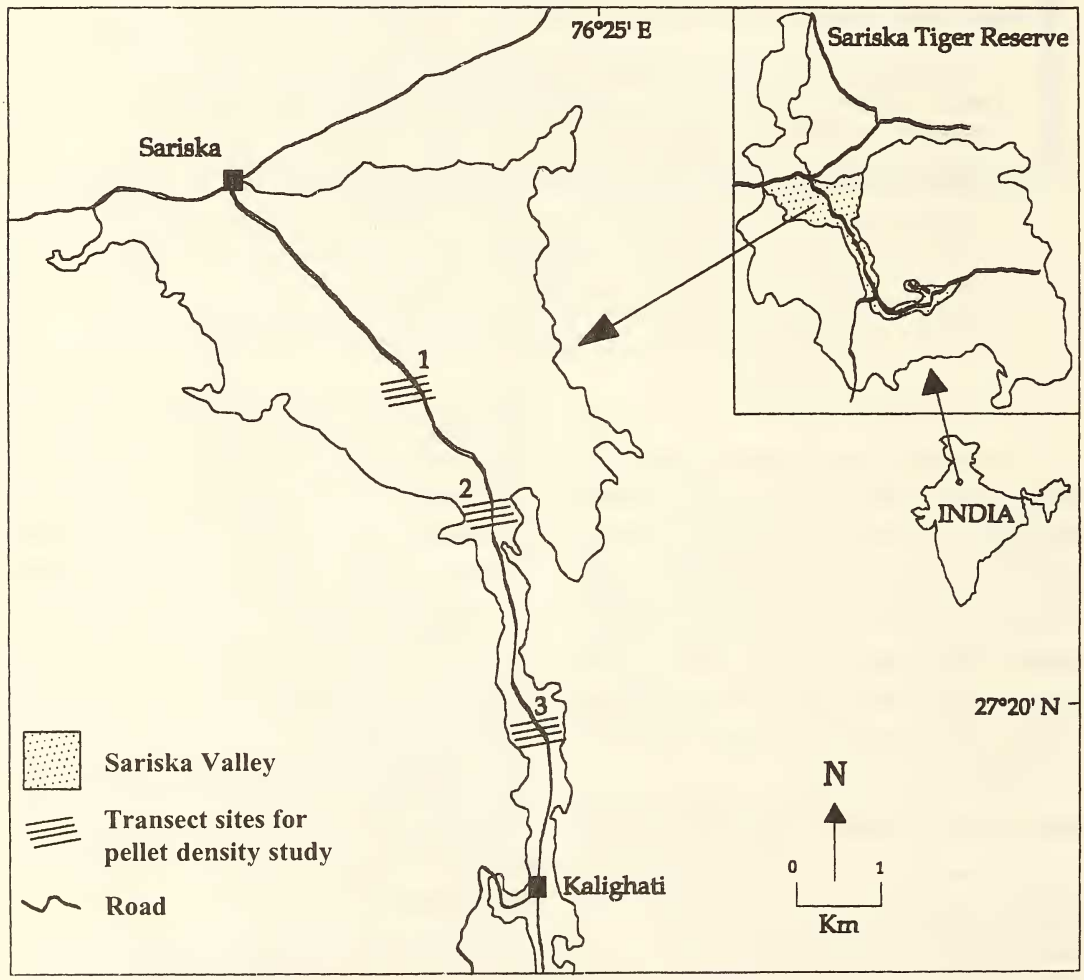

Fig. 1: Sariska valley showing the study sites

very little ground cover and litter in the three vegetation types during the study period.

The major mammals in the Sariska National Park include tiger (*Panthera tigris*), leopard (*P. pardus*), nilgai (*Boselaphus tragocamelus*), sambar (*Cervus unicolor*), chital (*Axis axis*), wild pig (*Sus scrofa*) and four-horned antelope (*Tetracerus quadricornis*). The density of animals, particularly of ungulates, is higher in Sariska valley, due to better habitat, than in other areas of the Tiger Reserve.

Methods

Direct Density Estimates

Since porcupines are nocturnal, they were counted at night using vehicle transects (Rodgers 1991), along a 10 km long road (Sariska to Kalighati), in Sariska valley. In June and July, the census was done 17 times, between 2000 to 2030 hrs, by four observers, in a jeep driven at a uniform speed of 20 km/hr. The animals seen in the headlights of the vehicle were recorded. The field covered by the headlights was 10 m on either side of the road. Porcupine density (D) was calculated using the fixed-width transect method (Rodgers 1991).

$$D = \frac{N}{2.L.B}$$

Where,
N = number of animals observed,
L = length of the transect in km, and
B = width on one side of the transect in km.

Indirect Density Estimates

Porcupine density (N) based on pellet group count, defecation and decay rate was calculated using the following equation (Barnes and Jensen 1987)

$$N = \frac{Y.r}{D}$$

Where,
Y = mean pellet group density (no./sq. km)
r = mean decay rate per day
D = mean defecation rate per day

Pellet group density: Porcupines defecate spindle shaped pellets, which are about 1-1.5 cm in diameter and 3-5 cm in length. The pellet number may range from 5-25 in a pellet group. Pellets groups were counted in strip transects in the three vegetation types, selected under stratified random sampling. Four strip transects 500 x 2 m were placed parallel to each other at 100 m intervals in each vegetation type (Fig. 1). Each transect was visited 17 times during May-June. The number of pellet groups that were available at the end of the study period after their accumulation and decay in each vegetation type was used to calculate the pellet group density i.e. the number of pellet groups per sq. km.

Pellet decay rate: Investigations of the decay rate of pellets were carried out from the first week of May 1989 to the second week of July 1989. Fresh pellet groups were located between May 10 and June 30. Eight groups of fresh pellets encountered were marked, counted and their condition monitored once a week. Two periods i.e. summer (May to mid-June) and pre-monsoon (mid-June to mid-July) were chosen to compare the seasonal decay rates.

The following equation was used (Barnes and Jensen 1987, Sukumar *et al.* 1991) to estimate the decay rate for pellet.

$$r = \frac{\ln(N_t)-\ln(N_{t-1})}{t}$$

Where,
r = mean decay rate of pellet groups per day,
N_t = number of pellet groups of one week,
N_{t-1} = the number of pellet groups of previous week, and
t = time (in days).

Defecation Rate: Two porcupines were observed in the National Zoological Park, New Delhi for 15 days, one in Sakkarbagh Zoo, Junagadh, for 19 days (in 1992) and another in Sayajibaug Zoo in Vadodara for 21 days (in 2000) and their pellet groups counted. The defecation rate was calculated as the number of pellet groups defecated per day.

Data was analysed using computer software. Non-parametric statistical tests were conducted for significance of results. Kruskal-Wallis tests were used to determine significance of variation among the three vegetation types, while Mann-Whitney U statistics were used to determine the significance of variation between the two seasons.

TABLE 1
DIRECT AND INDIRECT DENSITY ESTIMATES FOR PORCUPINE IN DIFFERENT HABITATS

Vegetation type	Pellet density	Animal density (No./km²)		Shrub density
	(No./km²)	Direct	Indirect	(No./ha)
Ziziphus scrubland	9975	2.35 ±2.16	24.9	411 ±114
Ziziphus woodland	350	6.56 ±1.04	0.9	137 ±63
Mixed woodland	5075	17.6 ±4.02	12.7	79 ±55
Average	5133	8.8 ±2.4	12.8	206 ±77

RESULTS

Pellet Group Density

There was a significant difference in the pellet group density among the three vegetation types (K-W tests χ^2=16.15, p<0.001, n=34) (Table 1).

Pellet Decay Rate

The pellet condition was categorised into five age groups (Table 2). Pellets observed from June onwards (after pre-monsoon showers) also disintegrated through the same categories, but the decay was faster in the second category.

Results indicated a large variation in the decay rates of different pellet groups within a season. Trampling by large mammals such as wild pig, sambar, chital and nilgai accelerated the process. On the other hand the pellets not trampled by large mammals were present even 60 days after being defecated in a moist environment. No termite action was observed in summer.

TABLE 2
PORCUPINE PELLET DECAY IN SUMMER (MAY TO MID-JUNE) AND PRE-MONSOON (MID-JUNE TO MID-JULY)

S. No.	Time (days) Summer	Pre-monsoon	Condition
1	< 1	< 1	Fresh, moist, covered with mucous, intact.
2	1-7	1-7	Intact, but dry.
3	8-30	8-15	Dry with cracks over the surface; more than 75% pellets distinguishable.
4	30-45	15-30	Cracks widen and colour becomes dark; about 50% or more still distinguishable.
5a		30-45	All pellets disintegrate.
5b	>45		Less than 50% distinguishable.

The pellet decay rate is shown in Figs 2 and 3. Table 3 shows the decay rate for various pellet groups monitored during summer and pre-monsoon. The average decay rate during summer was 0.005 per day. This rate increased to more than twice, 0.011 per day during pre-monsoon. The difference in the mean decay rates between summer and pre-monsoon was significant (M-W tests Z = 2.31, 2 tailed p<0.02, $n_{1,2}$ = 27,19). For calculation of animal density, only the decay rate during summer (May-June) are considered, as pellet group densities were estimated only in this season.

Defecation Rate

In the wild, the pellets were spindle shaped and discrete; while in the New Delhi zoo the pellets in a group were not as discrete. In Sakkarbagh Zoo (Junagadh) and Sayajibaug Zoo

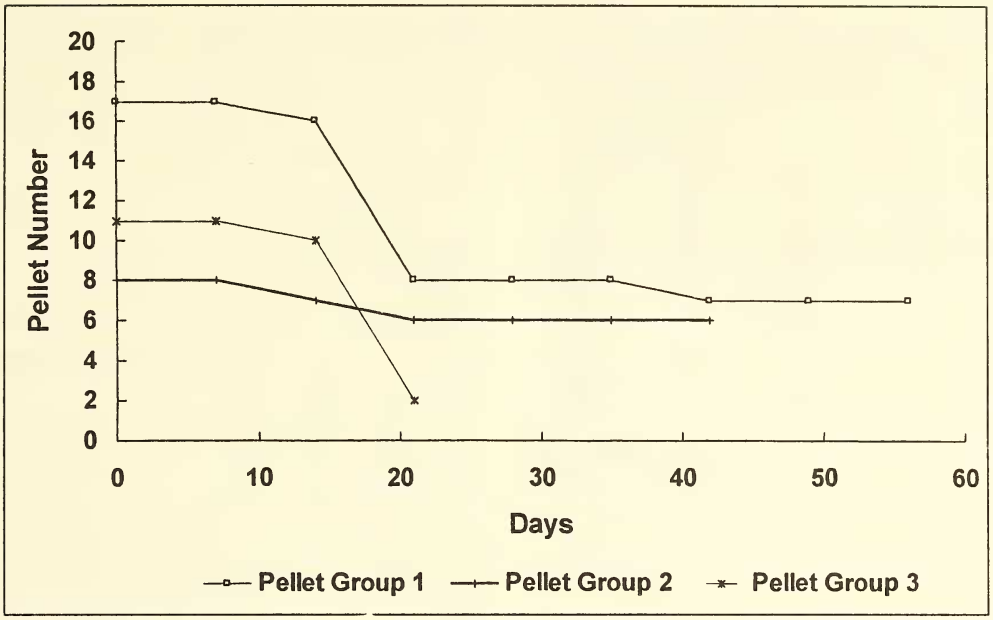

Fig. 2: Decay rate of porcupine pellets during summer

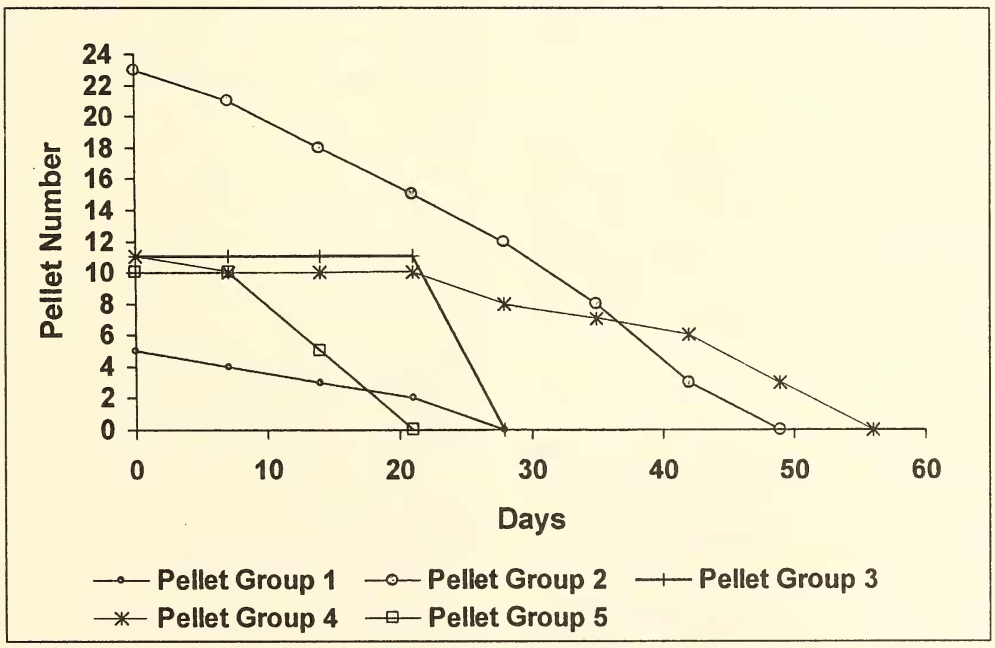

Fig. 3: Decay rate of porcupine pellets during pre-monsoon

TABLE 3
DECAY RATES OF VARIOUS PELLET GROUPS MONITORED DURING SUMMER AND PRE-MONSOON PERIODS

Pellet	Summer (May to mid-June)		Pre-monsoon (mid-June to mid-July)	
Group No.	Pellet group size	Decay rate (per day)	Pellet group size	Decay rate (per day)
1	17	0.005	5	0.010
2	8	0.004	23	0.012
3	11	0.011	11	0.014
4			10	0.020
5			11	0.007
Mean		0.005		0.011

(Vadodara), because of near natural diet, the droppings were similar to those in the wild and were included for calculations. The diet (including access to water) in captivity is different from that in the wild, hence the defecation rates should be taken only as an approximation. If possible, the defecation rate should be estimated in natural or semi-natural conditions. Defecation rate of porcupine in captivity varied from once to thrice a day. The average defecation rate was 2 ±0.15 per day (n = 40).

Animal Density

The results showed a difference between the direct and indirect estimates of density in each vegetation type (Table 1). The overall density estimated by direct observation was 8.8 ±2.4 animals per sq. km, while the estimate using indirect method was 12.9 animals per sq. km.

DISCUSSION

The road used for vehicle census at night passed through three different vegetation types, each of which differed from the others in structure, composition, density and utility to the porcupine (Sharma and Prasad 1992). This resulted in variation in porcupine density among the vegetation types. Due to the impact of drought and livestock grazing, the vegetation along the road was similar to that away from it. Therefore, it was presumed that porcupine movement and distribution along the roads would be similar to those away from the road. The small width (20 m) of the transect precluded the chances of missing animals on it. Within each vegetation type, density estimates from vehicle census at night had low variation, except in the case of *Ziziphus* scrubland. Further, the overall low variation in average density of the animals in the study area was considered good to compare indirect estimates with it.

The higher decay rate in pre-monsoon season (mid-June to July) was due to the action of dung beetles and termites. This started within a week after the first shower in the beginning of June. However, on hard (red soil) and bare ground the disintegration by termites took longer time.

Fresh pellets were not monitored after the onset of monsoon in July because of rapid disintegration. Often within a day or two about 50% or more of the pellets changed into an amorphous mass. Further, dense undergrowth did not permit an easy search of fresh pellets. Since the weather is dry for 8 months, the data collected during this period is considered to be more useful.

The observed differences in density estimates for the two methods were perhaps related to the shrub cover in the three vegetation types. Earlier results (based on debarking, Sharma and Prasad 1992), show that the porcupines preferred mixed woodland, *Ziziphus* woodland followed by *Ziziphus* scrubland as habitats. One would, therefore, expect the animal abundance and pellet density to follow this pattern. While the direct counts conformed to this pattern, the pellet density and indirect counts followed the reverse trend. This suggests that while the porcupines preferred to feed in mixed woodland and *Ziziphus* woodland, they spent substantial time in the dense undergrowth of *Ziziphus* scrubland. In *Ziziphus* scrubland, the

shrub density was the highest, followed by *Ziziphus* woodland and mixed woodland (Table 1). Dense shrub provides escape cover for the porcupine (Prater 1993).

This pilot study attempted to validate the methods used for indirect animal density estimates. Eberhadt and Etten (1956), Etten and Bennet (1965), Neff (1968) and Putman (1984) have comprehensively reviewed the limitations and sources of error in such a study. As revealed in this case, the differences in density estimates between direct and indirect evidence strongly emphasise the need for a proper stratification of habitat, preferably after reconnaissance, followed by adequate sampling (Grieb 1958). The results indicate that to estimate the population of nocturnal animals such as porcupine, one should study all habitats including those that may be avoided by the animal (Neu *et al.* 1974).

Even though most of these factors were taken into account (Sharma 1989) the defecation behaviour of porcupine may have played an important role in the indirect density estimates. The droppings were clumped, and under natural conditions were observed at certain locations only, while in captivity the animals defecated in the corners of the cages. This indicates the possibility of use of latrine sites by these animals. If so, can this method be used for other animals that use latrine sites?

Moreover, the semi-arid climate seems to have played an important role in substantially slowing down the decay rate of pellets. Pellets of chital and sambar defecated in the previous year have been observed in Gir Wildlife Sanctuary and National Park in Gujarat by this author, indicating their slow decay rate in similar conditions. These aspects require more research and, perhaps, the inclusion of a correction factor in the calculation of densities in such conditions.

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